2.0 Introduction

2.1 Project Description

The proposed project consists of the reconstruction of a 6.7 mile segment of Interstate 94 (I-94) in the City of Detroit, Michigan. The project begins just east of the I-94/I-96 interchange and extends northeasterly to east of the I-94/ Conner Avenue interchange. The project includes the reconstruction of two major freeway-to-freeway system interchanges: I-94 at M-10 (John C. Lodge Freeway) and I-94 at I-75 (Chrysler Freeway). It also includes the reconstruction of a number of partial and full-service interchanges with local arterial streets. A number of pedestrian and vehicle bridges cross over the I-94 freeway. These bridges will be removed, and some of them will be replaced. This section of existing I-94 was built in the 1950's.

The proposed project study was initiated by MDOT in 1994 and is currently in the final environmental documentation phase.

The average annual daily traffic (AADT) in the project area ranges from 120,000 to over 160,000 vehicles, and it is expected to grow by more than 35 percent by the year 2025. Heavy truck traffic on I-94 is expected to grow three times faster than the passenger vehicle volume in the next 20 years, due to I-94's link to international border crossings and the growing economy in southeast Michigan. The traffic crash rate ranges from 350 to 762 crashes per 100 million vehicle miles traveled on I-94, which exceeds the Detroit freeway average rate of 350 crashes per 100 million vehicle miles traveled.

The proposed project includes construction of continuous service drives along the corridor and through the M-10 and I-75 interchange. Local traffic now uses I-94 for local access because the few service drives are not continuous along the corridor and through the interchanges. Access between neighborhoods will be addressed, where possible, to provide improved access to residences, businesses and other institutions within the project corridor.

The proposed project will require the acquisition of 40 to 60 residences and businesses, plus possible acquisition or impact to additional vacant parcels, along the project corridor. The major components of the proposed construction project are summarized as follows:

- I-94 mainline from east of I-96 to M-10
- Bridges from east of I-96 to M-10
- I-94/M-10 interchange, including service drives and bridges
- M-10 Mainline from south of Canfield to Milwaukee
- I-94 mainline from M-10 to I-75
- Bridges from M-10 to I-75
- I-94/I-75 interchange, including service drives and bridges
- I-94 mainline from I-75 to Conner Avenue
- Bridges from I-75 to Conner Avenue
- I-94/Gratiot Avenue interchange, including service drives
- I-94/Conner Avenue interchange, including service drives
- Remainder of service drives from east of I-96 to east end of project

The schedule for the project, as presented to the value engineering (VE) team, is defined as follows: A Record of Decision on the Final Environmental Impact Statement is anticipated in late 2004. Selection of engineering firms for the design of the project is anticipated in early 2005. Preliminary engineering (to approximately 30% design completion) is anticipated to occur through 2005 and 2006. Final engineering and preparation of construction documents is anticipated to occur in 2007 until early 2008. Construction is anticipated to begin in 2008.

The estimated cost of the project, as presented to the VE team, is summarized as follows. The costs are in 2002 dollars:

Construction Costs:	$906,600,000
Right-of-Way:	$ 52,500,000
Total Cost:	$959,100,000

2.2 Project Purpose and Need

The project purpose and need is quoted as follows from the I-94 Rehabilitation Project Recommended Alternatives Analysis, CS 82023 & 82025 – JN 32587 Final Report, prepared for MDOT by Parsons Brinckerhoff Michigan, Inc., dated August 2002: "The primary purpose of the Interstate 94 (I-94) Rehabilitation Project is to replace the existing pavement, replace the aging bridges, provide additional capacity to meet 20 year projections, improve safety, replace the aged drainage system, and improve traffic operations on a 6.7 mile segment of I-94 in the City of Detroit. Proposed improvements will also enhance local traffic circulation, improve community access, address environmental concerns, support economic growth, and contribute positively to the surrounding neighborhoods."

In August 2003, the Detroit City Council and Mayor's Office approved the alternative recommended in the Draft Environmental Impact Statement. The City Council requested 11 changes. The following listing summarizes how the changes are being addressed, as listed in an I-94 Rehabilitation Project Newsletter dated October 2003 (see Exhibit 7.3 for copy of Newletter):

1. The 55 ft. reserved median space in the proposed I-94 mainline typical section has been removed as requested.
2. For the continuous service drives, two lanes with an 8 ft. shoulder will be provided. Based on 2025 traffic demand, three lanes on the eastbound service drive between M-10 and I-75 will be provided.
3. Hendrie Street access has been redesigned to address the request for the addition of a street east of Woodward and parallel to the service drive for local traffic in order to protect the residences along Hendrie Street.
4. MDOT clarified documentation of the project limits, and an Environmental Assessment will not be included as part of the project.
5. The project's EIS includes Detroit Intermodal Freight

Terminal Study's impact on truck traffic as requested.

6. In the preliminary design, MDOT has reduced spacing between the auxiliary lanes and the mainline lanes as much as possible and has tightened ramp geometrics in order to limit the taking of private property. Further efforts to address these concerns will be undertaken in final design.
7. MDOT will address noise mitigation according to FHWA guidelines, in response to the issue of special consideration of schools regarding noise mitigation.
8. MDOT is considering construction mitigation funding for buses, in response to the request of using rapid transit as a traffic construction mitigation component, through flexible TEA 21 funding in the corridor.
9. Regarding the issue of correction of existing noise and air quality violations, MDOT will correct existing air and noise quality violations according to FHWA guidelines.
10. Regarding the issue of securing all funding for noise barriers – walls, landscaping, buffering, etc. – as well as funding for modifications of streets intersecting the service drives and on-going maintenance of the barrier walls before any highway approvals are given, MDOT clarified that memorandums of understanding will be developed between the City and MDOT describing funding share and exact maintenance responsibilities.
11. The railroad right-of-way east of I-75 and south of I-94 will remain as a rail corridor. Rail for the region is currently being addressed in separate studies.

2.3 Scope of Value Engineering Assignment

The scope of the VE assignment for the VE team consisted of the following areas:

1. Review Early Preliminary Engineering (EPE) material, information, and data to date, in an effort to identify any value matches and mismatches.
2. Validate that the project recommended alternate can be constructed within the indicated right-of-way footprint.
3. Identify any design or operational constraints if the proposed alternate is built as currently shown, especially ramp grades, speeds, and bridge underclearances through the two freeway system interchanges.
4. Review the cost estimates listed in the information provided.
5. Investigate alternative construction stages and segments, including costs associated with each stage or segment.
6. Review other possible design alternatives that would improve EPE features within the right-of-way footprint.
7. Identify significant EPE items not given to the VE team, not studied to date, or not in current cost estimates.
8. Recommend additional items to be included in the FEIS to allow the project to proceed as scheduled.

2.4 Value Engineering Process

The process used for this VE Study followed the typical VE Work Plan, consisting of a series of structured phases. These phases and their purposes are generally defined as follows:

Information Phase

The purpose of the Information Phase is to gain an understanding of the project and the stakeholders affected by the project. The information phase can be summarized as follows:

- presentation of the project by the designers to the VE team;
- review all relevant information on the project, including the project description and scope of work;
- identify the owners, users and stakeholders;
- identify the needs, desires and constraints of the owners, users and stakeholders;
- use the stakeholder needs, desires and constraints, to develop project related functions;
- determine the task, basic function(s) and supporting functions of the project;
- estimate the cost of project elements and each critical function; and
- analyze the owner's and stakeholder's attitude toward each function.

Speculation Phase

The purpose of the Speculation Phase is to apply brainstorming techniques to identify ideas for the proposed project design, generating a large list of potential (creative) items; explore performing functions that will enhance performance or acceptance at a reasonable cost; and assess cost/worth relationships.

Evaluation Phase

The purpose of the Evaluation Phase is to identify the most outstanding alternatives for further development. This identification is accomplished through a series of screening processes that will sort the ideas by comparison and combination. Using these ideas, alternatives will be developed. These alternatives will be rated, considering such evaluation criteria as performance, acceptance and cost.

Development Phase

The purpose of the Development Phase is to add information that will facilitate selection of a preferred alternative. This will be accomplished through a comparison among the remaining alternatives. The following rules should be considered during the Development Phase:

- Recognize ideas that may be unique.
- Conduct research, as required, to provide additional information.
- Analyze the weaknesses of the selected alternatives and provide improvements.

Presentation Phase

The purpose of the Presentation Phase is for the VE team to present its recommendations to appropriate owner's staff who must evaluate and implement the findings. The presentation is supplemented with graphics, handouts and other material necessary to document the viability of the recommendations.

Resolution/Implementation Phase

The purpose of the Resolution/Implementation Phase is for the owner's staff to offer full and fair evaluation of all recommendations, and implement those determined to be viable. The owner's staff will determine one of three dispositions of each recommendation:

1. Accept for Implementation;
2. Accept for Further Study Before Determining Implementation; or
3. Reject (for these reasons).

2.5 Value Engineering Study Date and Site

MDOT retained the following firms to perform a VE Study for this project:

- Alfred Benesch & Company (Benesch)
- HNTB Michigan, Inc., (HNTB) in association with Bloom Consultants, LLC (Bloom)
- Parsons Brinckerhoff Michigan, Inc. (PB)
- URS Corporation (URS)

The VE study was conducted over a period of three weeks. Session 1 was held from February 29, 2004 through March 5, 2004. Session 2 was held from March 15, 2004 through March 18, 2004. The firms worked on validation of the project footprint and development of ideas during the week between Sessions 1 and 2.

The VE study and all presentations and meetings were held at the Marriott Courtyard Hotel in downtown Detroit. MDOT staff conducted a drive-through of the project corridor for the VE team on February 29, 2004.

MDOT staff gave an informational phase presentation to the VE team on March 1, 2004. The presentation was given by Win Stebbins, Mohammed Alghurabi and Mike O'Malley. A checkpoint review was given by the VE team to MDOT staff on March 4, 2004. A copy of the attendance list for this review is included in Section 7.0 as Exhibit 7.2.

The VE team gave an intermediate summary presentation to Win Stebbins of MDOT on March 15, 2004. This presentation focused on a brief summary of the progress of assignments during the week between Sessions 1 and 2.

The VE team gave a summary presentation of the results of the VE study to MDOT on March 18, 2004. A copy of the attendance list and the presentation is in Appendix C.

2.6 Value Engineering Team

The following individuals comprised the multidisciplined VE team:

Name	Company	Role
Muthiah Kasi, PE, CVS	Benesch	Co-Facilitator
Darrell Berry, PE, VMP	Bloom	Co-Facilitator
Laura Aylsworth-Bonzelet, PE	URS	Road Engineer
Cedric Dargin, PE	MDOT	Construction Engineer
Steve Fleming, PE	PB	Road Engineer
John Friel, PE	HNTB	Construction Engineer
Richard Hill, PE	Benesch	Road Engineer
Terry Horst, PE	HNTB	Road Engineer
Albert Kaltenthaler, PE	Benesch	Bridge Engineer
Peter Kinney, PE	HNTB	Road Engineer
Bill Lambdin, PE	HNTB	Bridge Engineer
Marge Lauer, PE	PB	Construction Engineer
Kevin Mullins, PE	Benesch	Bridge Engineer
Paul Sander	MDOT	Real Estate
Khaled Soubra, PE	URS	Bridge Engineer
Ed Strada, PE	HNTB	Road Engineer
Douglas Strauss, PE	Benesch	Road Engineer

The following individuals provided information to the VE team.

Win Stebbins, PE	MDOT	VE Coordinator
Mohammed Alghurabi, PE	MDOT	I-94 Project Manager
Mike O'Malley	MDOT	Environmental Unit

Administrative assistance was provided by the following individuals:

Jayne Hill - Benesch (Session 1)
Kim Pingle - HNTB (Session 1)
Janet Lennie - Benesch (Session 2)

3.0 Information Phase

Purpose

The purpose of the Information Phase is to gain an understanding of the project. Among the questions to be answered in this phase are:

- What is the project?
- What does it do?
- What should it do?

3.1 Information Provided to the Value Engineering Team

The following information was provided to the VE team by MDOT:

1. Project drive-through, narrated by Win Stebbins and Mohammed Alghurabi on 2/29/04
2. Presentation by Win Stebbins, Mohammed Alghurabi and Mike O'Malley on 3/1/04
3. Recommended Alternatives Final Report - August 2002
4. DEIS Report - January 2002
5. Traffic Report - August 2002
6. Cost Estimates:
   - Recommended Alternative
   - Enhanced No Build
   - Right-of-way (ROW)
7. Aerial Exhibits:
   - Showing ROW (1"=100')
   - Traffic Level of Service (1"=150')
   - DEIS Geometric (1"=1000')
8. Compact disk (CD) with photos; also binder prepared by Benesch
9. CD with photos of buildings & cultural features
10. CD with utilities
11. CD with DEIS Build Alternatives (metric)
12. CD with plan digital terrain model (DTM) & contour files
13. CD with plan exhibit (U.S. Customary Units)
14. CD with DEIS plan & profile images
15. CD with recommended ROW images
16. Documents:
    A. Meeting Minutes for Geometric and Signing Meetings
    B. Review of Geometrics - memos by CH2M Hill, including responses from November 2001
    C. Design Criteria
    D. Inventory of bridges
    E. List of bridges to be removed
17. October 21 & 22, 2003 Public Information Meeting - Comments; MDOT web site has summary of this meeting
18. Email February 27, 2004:
    - Access Connections & Design
    - Commitment List to Accomplish Final Environmental Impact Statement (FEIS)
    - Recommended Alternatives - Building & Building Parcels Affected
19. Dequindre Bridge record drawings
20. Photographs of potentially historic properties and structures
21. I-94 Rehabilitation Newsletter, October 2003 (given to VE team 3/4/04)
22. Engineering Commitments and/or Items to be Studied During Engineering Report (undated)
23. Design Exceptions and Ramp Terminal Spacing Memorandum (undated)

The following additional information was provided in response to questions or requests for information from the VE team:

1. Railroad bridges (2) north of I-94 on I-75:
   Are they removed? *No.*
   Will they be removed? *Yes, mostly likely prior to this project beginning.*
2. Dequindre Bridge:
   - As Built plans: *Provided on 3/2/04.*
   - Confirmation of at-grade service drives: *Yes, but they will have structures over railroad tracks.*
   - Widening of westbound section of bridge (north side): *Yes, that is the current intent.*
3. Cost Estimate confirmation w/backup data & date: *Nothing else is available. Cost estimate was done in 2001 and revised by applying factors in August 2002.*
4. Cost Estimates for RR bridges over I-94 at west end & over Lodge Fwy.: *Costs were not included with this project because they will be replaced by the railroads.*
5. Cultural resources maps: *Provided on 3/2/04.*
6. Location of noise barriers: *Not known or defined yet.*
7. Inventory of design exceptions: *Provided on 3/2/04.*
8. Value Planning Report (2000): *Not provided.*
9. October 2003 Public Information Meeting Summary: *Provided on 3/2/04.*
10. Access Justification Report (AJR) pre-final draft report: *Excerpts from Draft AJR provided on 3/2/04.*
11. Listing of one-way to two-way streets: *Provided on 3/1/04; only 2nd Street and Brush Street will become two-way.*

3.2 Owners, Users and Stakeholders

Following the description of the project provided by MDOT, and following the questions from the VE team, a list of owners, users and stakeholders was developed for this project. The following definitions were used.

Owner - One who is:

1. Financially responsible for funding the project;
2. Shares in the funding;
3. Represents the owner(s) interests; or
4. Manages the project.

User - One who actively, physically uses the product/project or maintains the product/project.

Stakeholder - Anyone who is:

1. Financially affected by the project;
2. Environmentally concerned about the project; or
3. Disturbed by a required change in habits or recreation.

3.0 Information Phase

The following is a list of Owners, Users, and Stakeholders.

1.	MDOT	O
2.	Public	U
3.	Residents	S
4.	City of Detroit	O, S
5.	Federal Highway Administration (FHWA)	O
6.	Railroads (Conrail, Grand Trunk Western, CN)	O, S
7.	Wayne State University	S, U
8.	Detroit Water & Sewer Dept. (DWSD)	S, O
9.	Wayne County	S, U
10.	General Motors	U, S
11.	Public Lighting Dept. (PLD)	S, O
12.	Michigan Intelligent Transportation System Center (MITSC)	O, S, U
13.	New Center Business/Residential Neighborhood Group	U, S
14.	Henry Ford Hospital	U, S
15.	Detroit Dept. of Transportation	U, S
16.	Suburban Mobility Authority for Regional Transportation (SMART)	U, S
17.	Wayne County Community College	U, S
18.	Emergency Medical System (EMS - Police, Fire, Ambulance)	U, S
19.	Freight Truck Traffic	U, S
20.	Southeastern Michigan Council of Government (SEMCOG)	S
21.	Pedestrians	U
22.	Bicyclists	U
23.	Research Park (low income housing)	U, S
24.	City Airport	S
25.	City of Ferndale	S
26.	Waste Facility (Waste Management)	S
27.	Packard Building	S
28.	Historical Groups	S, U
29.	Casinos	S, U
30.	University Culture Center Association	S
31.	Michigan Dept. of Environmental Quality (MDEQ)	S
32.	State of Michigan	U, S
33.	Private Utility Companies	U, S
34.	Motorists (General) - through & local	U, S
35.	Businesses	U, S
36.	Local Industrial Facilities	U, S
37.	I-94 Traffic	U, S
38.	I-75 Traffic	U, S
39.	I-96 Traffic	U, S
40.	M-10 Traffic	U, S
41.	Conner Interchange Users	U, S
42.	Van Dyke Interchange Users	U, S
43.	Gratoit Interchange Users	U, S
44.	Contractors	U, S
45.	Designers	S, U, O
46.	Environmental Protection Agency (EPA)	S
47.	Detroit Medical Center	U, S
48.	Homeland Security	S
49.	Traffic with Hazardous Materials	U
50.	MDOT Construction	O
51.	MDOT Real Estate	O
52.	MDOT Environmental	O
53.	MDOT Design	O
54.	MDOT Hydraulics	O
55.	MDOT Traffic	O
56.	MDOT Maintenance	O
57.	MDOT Geotechnical	O
58.	MDOT Planning	O
59.	MDOT Freeway Lighting	O
60.	MDOT Utilities	O
61.	Detroit Parks & Recreation Dept.	S, U
62.	Housing and Urban Development (HUD)	S
63.	Detroit Public Lighting	S, U
64.	Greater Detroit Recovery (Steam System)	S
65.	Local Churches	U, S
66.	Traffic Crossing Border to or from Canada	U, S
67.	Detroit Economic Develop Corp	S
68.	Traffic for Joe Louis Arena & Cobo Hall	S
69.	Tourists	U
70.	Visitors for Downtown Cultural Events & Sports Events	U
71.	All-Star Baseball Game Traffic (2005)	U
72.	Super Bowl Traffic (2006)	U
73.	National Collegiate Athletic Association (NCAA) Final Four (2009)	U
74.	Metro Airport	S
75.	Citizens Advisory Committee	S, U
76.	Detroit Marine Terminal	S, U
77.	Highland Park & Hamtramck	S
78.	Transit Users	U
79.	Detroit Downtown, Inc.	S
80.	Woodbridge Neighborhood Historical District	S, U

3.3 Needs, Desires and Constraints

Needs, desires and constraints are developed from a stakeholder perspective. Therefore, it is possible that one stakeholder's constraint may conflict with another stakeholder's need or desire. No attempt is made to resolve such conflicts at this time. The goal is to understand what each stakeholder is expecting from the completed project.

Needs Are:

Expectations that must be fulfilled by the project, if constraints are not violated.

Limitations or restrictions that are imposed by various users and other stakeholders but which can be violated. The degree of violation will be considered in the evaluation of alternatives.

Desires Are:

Expectations that should be fulfilled if cost is not a factor.

Constraints Are:

Constraints are usually defined by legal requirements, standards of the client, physical conditions of the site and commitments to the community. Any idea that violates a constraint is eliminated during the Preliminary Evaluation.

The following lists the owners', users' and stakeholders' Needs, Desires and Constraints.

Needs

1. Maintain neighborhood
2. Provide minimum 14'-6" underclearance
3. Increase capacity on freeway
4. Provide safety
5. Improve roadway
6. Improve bridges
7. Maintain access during construction
8. Provide routing for major traffic generators
9. Maintain drainage
10. Accommodate pedestrians
11. Mitigate noise
12. Maintain air quality
13. Maintain railroad service
14. Eliminate left-hand exits
15. Provide adequate ramp width for future maintenance
16. Provide smooth ride
17. Meet current design criteria
18. Maintain access to businesses during construction
19. Maintain freeway-to-freeway access during construction
20. Establish alternate routes for regular truck traffic
21. Provide stormwater detention
22. Provide structures to carry loads
23. Mitigate ground contaminants
24. Minimize excavation for retaining wall
25. Protect driver
26. Improve sight distance
27. Provide skid resistance
28. Provide signing
29. Provide erosion protection
30. Care for the homeless
31. Provide minimum 0.3 percent grades
32. Provide security for construction workers
33. Provide fence
34. Provide fire protection
35. Provide horizontal clearance
36. Provide three-lane service drive between M-10 & I-75, south side
37. No replacement of Dequindre Bridge
38. No freeway traffic on city streets during construction
39. Avoid Research Park apartments
40. Avoid Wayne State University parking garages (3)
41. Cannot eliminate traffic flow around north end of Department of Public Works building
42. No ROW from Kettering High School
43. No ROW at Wayne County Community College at Conner
44. Avoid "4th Street Community"
45. Maintain truck access under Dequindre Bridge
46. Maintain I-75 as it exists today
47. Avoid transit facility building
48. Accommodate through traffic on only a limited number of freeway to freeway detour routes

Desires

1. Provide continuous service drives
2. Improve corridor aesthetics
3. Improve drainage
4. Reduce noise
5. Enhance (improve) air quality
6. Minimize project construction cost
7. Minimize real estate acquisition
8. Maintain bus routes
9. Minimize construction duration
10. Maintain local traffic patterns
11. Improve access to General Motors (GM) Facility
12. Improve level of services (LOS) for intersections
13. Eliminate design exceptions
14. Minimize utility impacts
15. Minimize impact to schools
16. Minimize future maintenance
17. Provide landscaping between freeway and service drives
18. Incorporate context sensitive design features
19. Improve geometrics
20. Improve lighting
21. Provide lighting along service drives
22. Upgrade Intelligent Transportation System (ITS)
23. Design I-94 for 70 m.p.h.
24. Use advance contracts (i.e., for RR bridges)
25. Establish alternate routes for regular traffic
26. Establish alternate routes for traffic with hazardous material
27. Consider design/build contracts
28. Provide lighting on pedestrian bridges
29. Stage construction alternate interchanges
30. Minimize impact to Wayne State University athletic field
31. Eliminate utilities from bridges.
32. Make allowances for future rapid transit.
33. Incorporate crash investigation sites.
34. Optimize traffic signals.
35. Minimize joints on bridges.
36. Balance retaining wall needs with ROW needs.
37. Relocate drainage to outer edge of shoulder.
38. Accommodate bicyclists.
39. Accommodate space for emergency vehicle and vehicle breakdown use.
40. Minimize mitigation requirements (i.e., green space needs by housing development)
41. Provide uniform pavement section.
42. Provide lane delineators.
43. Minimize signs on bridges.
44. Provide free flow connection between service roads & mainline.
45. Provide auxiliary lanes on mainline.
46. Provide 2 percent cross slope on local bridges.
47. Provide 2 percent cross slope on service drives instead of parabolic.
48. Provide corridor theme.
49. Provide flush shoulders.
50. Unify bridge designs/economy of scale.

Constraints

1. Stay within right-of-way footprint identified in DEIS and Recommended Alternative Report, August 2002
2. Avoid historic Packard building
3. Avoid historic Cass Motors building
4. Schedule: Cannot go back for reevaluation of EIS or supplemental EIS
5. Cannot violate local ordinances, such as for access - commercial traffic through a neighborhood
6. Provide minimum 14'-6" vertical clearance at vehicular bridges and 15'-6" at pedestrian bridges
7. Avoid Woodbridge Historic District

3.4 List of Project Functions (Project Perspective)

Functions that the project should fulfill are derived from the list of stakeholder needs, desires and constraints. However, at this point, the VE team has to make judgements about any conflicts between what various stakeholders expect from the project. That is, the functions are considered from the project perspective. Where it is not possible for the VE team to resolve conflicts, each need, desire or constraint is listed as a function.

4.0 Cost Analysis

4.1 Draft EIS Cost Estimate

The summary cost estimate for the draft environmental impact statement (DEIS) report is included in this report as Exhibit 4.1.

The DEIS cost estimate was computed by estimating the quantities and unit costs of certain easily quantifiable project elements. The total of these costs is $345,333,946. This cost does not include utilities, traffic control, contingency, mobilization, enhancement, engineering, or right of way (ROW). These less quantifiable project elements, with the exception of ROW, are estimated with percentages, and are calculated as follows:

Base Cost	= $345,333,946	
Utilities	= 15% x $345,333,946	= $51,800,092
Subtotal	*= $345,333,946 + $51,800,092*	*= $397,134,038*
Traffic Control	= 15% x $397,134,038	= $59,570,106
Subtotal	*= $397,134,038 + $59,570,106*	*= $456,704,144*
Contingency	= 25% x $456,704,144	= $114,176,036
Subtotal	*= $456,704,144 + $114,176,036*	*= $570,880,179*
Mobilization	= 10% x $570,880,179	= $57,088,018
Subtotal	*= $570,880,179 + $57,088,018*	*= $627,968,198*
Enhancements	= 10% x $627,968,198	= $62,796,820
Subtotal	*= $627,968,198 + $62,796,820*	*= $690,765,018*
Engineering	= 25% x $690,765,018	= $172,691,255
Subtotal	*= $690,765,018 + $172,691,255*	*= $863,456,272*

The cost by section of this report is shown in Exhibit 4.2. The original ROW calculation of $35,019,540 was rounded up and reported as $50,000,000 in the DEIS cost estimate. The total cost estimate, including ROW, for the DEIS was therefore calculated as $913,456,273 in 2001 dollars.

To bring the costs to 2002 dollars, the grand total was increased by 5 percent. The total for 2002 is $959,129,000.

VE Comments on DEIS Cost Estimate:

At the end of the Information Phase of the study, the VE team identified the following comments on the DEIS cost estimate:

1. The costs for the two railroad bridge replacements at the west end of the project are not included, even though such costs might be borne by the project.
2. The costs for reconstruction of M-10 south of the interchange with I-94 are not included.
3. Earthwork costs are not calculated, and are assumed to be included with the contingency item or pavement unit costs.
4. The quantities had not been updated since at least 2001, and possibly not since 1999.
5. Using compounded percentages for various items in the cost estimate is not typical. For instance, applying a factor of 2.63 to the estimated construction costs for bridges and other items is excessive.
6. The cost estimate had not been updated to 2004 dollars.
7. Mobilization costs are typically in the range of 3 to 5 percent of the total estimated construction cost.
8. Traffic Control Costs ($59,570,000) seem excessive.
9. Enhancement Costs ($62,797,000) seem excessive.

During the development of the validation items and design proposals, several additional discrepancies were identified. These are as follows:

- The lists of bridge demolition and proposed bridges in the cost estimate does not correlate with the recommended alternative exhibits.

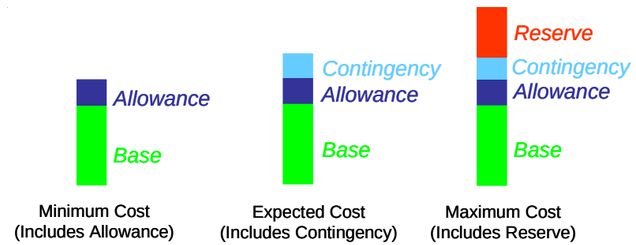
- Two Public Lighting Department Regulator Houses will need to be relocated but are not identified in the cost estimate.

- The costs for retaining walls will likely exceed the costs identified, due to the need for taller walls than assumed in the cost estimate. In addition, the unit prices assumed appear to be low.

4.2 VE Approach to Cost Model

For the value engineering study, an ASTM cost model was used to define and validate the DEIS cost model and to derive function costs. The cost model is based on the ASTM Standard Classification for Allocated Sums in Construction Estimating, and it was modified by Alfred Benesch & Company.

The ASTM cost model organizes the costs into four categories: base cost, allowance, contingency, and reserve. These cost categories are defined by the probability of their being spent and the reliability of the knowledge upon which their costs are based. The categories are defined as follows:



The details of the Cost Model are explained in Section 8.3.

Summary of Costs (Draft EIS)

ITEM NUMBER	ITEM	UNIT	UNIT COST	QUANTITY & TOTAL COST	
				QTY.	COST
1	ASPHALT PAVEMENT (6/12 SECTION)	sq. yd.	$11.70	333,170	$ 3,898,092.12
2	CONCRETE PAVEMENT (12/12 SECTION)	sq. yd.	$90.00	770,093	$ 69,308,410.00
3	3" MILL & OVERLAY	sq. yd.	$9.00	68,442	$ 615,981.00
4	REMOVAL OF SURFACING	sq. yd.	$1.70	1,247,543	$ 2,120,822.83
5	CURB & GUTTER	ft.	$7.65	206,080	$ 1,576,509.71
6	SIDEWALK	sq. ft.	$2.50	530,714	$ 1,326,785.00
7	CONCRETE MEDIAN PAVEMENT	sq. ft.	$3.40	129,700	$ 440,980.00
8	BRIDGES	sq. ft.	* N/A	N/A	$ 141,022,850.00
9	RETAINING WALLS	sq. ft.	$60.00	343,114	$ 20,586,850.80
10	REMOVAL OF STRUCTURES	lump sum	lump sum	1	$ 19,876,000.00
11	SIGNALS	per inters.	$100,000.00	52	$ 5,200,000.00
12	LIGHTING	lump sum	lump sum	1	$ 10,000,000.00
13	SIGNING	lump sum	lump sum	1	$ 13,000,000.00
14	STRIPING	lump sum	lump sum	1	$ 241,290.00
15	RR CROSSING	per xing	$100,000.00	4	$ 400,000.00
16	DRAINAGE	lump sum	lump sum	1	$ 22,219,375.00
17	PUMP STATIONS	each	$2,000,000.00	6	$ 12,000,000.00
18	CONCRETE WALL BARRIER	ft.	$90.00	150,000	$ 13,500,000.00
19	LANDSCAPING	lump sum	lump sum	1	$ 8,000,000.00
				SUBTOTAL COST=	**$345,333,946.45**
				UTILITIES (15%) =	**$51,800,091.97**
				TRAFFIC CONTROL (15%) =	**$59,570,105.76**
				CONTINGENCY (25%) =	**$114,176,036.05**
				MOBILIZATION (10%) =	**$57,088,018.02**
				ENHANCEMENT (10%)=	**$62,796,819.82**
				SUBTOTAL COST =	**$690,765,018.07**
				ENGINEERING (25%)=	**$172,691,254.52**
				ROW=	**$50,000,000.00**
				GRAND TOTAL IN 2001 DOLLARS=	**$913,456,272.59**
	* UNIT COST FOR INTERCHANGE BRIDGES IS $120/sf * UNIT COST FOR RAILROAD BRIDGES IS $175/sf * UNIT COST FOR BRIDGES OTHER THEN INTERCHANGE AND RAILROAD IS $80/sf				
				GRAND TOTAL IN 2002 DOLLARS =	**$959,129,000.00**
				GRAND TOTAL IN 2004 DOLLARS =	**$1,057,440,000.00**

Exhibit 4.1

See Appendix A for the detailed DEIS cost information.

Cost by Section (Draft EIS)

Project Location	Cost (in millions)
Conner Interchange and Service Drives Conner to Springfield	$ 8.88
Gratiot Interchange and Service Drives Bewick to Rohns	$ 9.03
Service Drives from Harper to Mt. Elliott	$ 3.26
M-10 Interchange (including service drives)	$ 198.87
I-75 Interchange (including service drives)	$ 191.08
Remainder of service drives from I-75 to east end of project	$ 46.25
Service drives from M-10 to I-75	$ 18.19
Service drives from east of I-96 to M-10	$ 21.40
Bridges from east of I-96 to M-10	$ 17.41
Bridges from M-10 to I-75	$ 32.45
Bridges from I-75 to Conner	$ 79.97
Mainline from east of I-96 to M-10 (minus bridges in the section)	$ 52.23
Mainline from M-10 to I-75 (minus bridges in the section)	$ 57.68
Mainline from I-75 to Conner (minus bridges in the section)	$ 169.93
ROW	$ 52.50
Total Cost of Mod 1 Estimated in 2002 dollars	**$ 959.13**
Total Cost of Mod 1 Estimated in 2004 dollars	**$ 1,057.44**

Exhibit 4.2

The VE team identified the following elements as having the largest impact on the project cost:

- Mainline
- Interchange at M-10
- Interchange at I-75
- Bridges
- Retaining walls
- Drainage
- Service drives

The VE study focused on these elements.

5.0 Function Analysis

The next step in the function analysis process is to develop the Function-Logic Diagram.

5.1 Function-Logic Diagram

The function-logic diagram is a tool to help the VE team put the functions in an order and to better understand what the project is expected to do.

The sequence of functions in the function-logic diagram proceeding from left to right answers the question "How is the function to its immediate left performed?"

The sequence of functions proceeding from right to left answers the question "Why is the next function performed?"

In the function-logic diagram shown in Exhibit 5.1, the functions are grouped into three categories:

- Task
- Basic Functions
- Enhancing Functions

The task is the reason or purpose for the project. It answers the "why" question of the basic function.

The basic function is the primary purpose or most important expectation from the project. The basic function must always exist, although the methods or designs to achieve it may vary.

The enhancing functions support the basic function and result from the specific design approach chosen to achieve the basic function. As shown in the function-logic diagram, the enhancing functions are grouped into four subcategories:

- Assure Dependability
- Assure Convenience
- Satisfy Stakeholder
- Attract Stakeholder

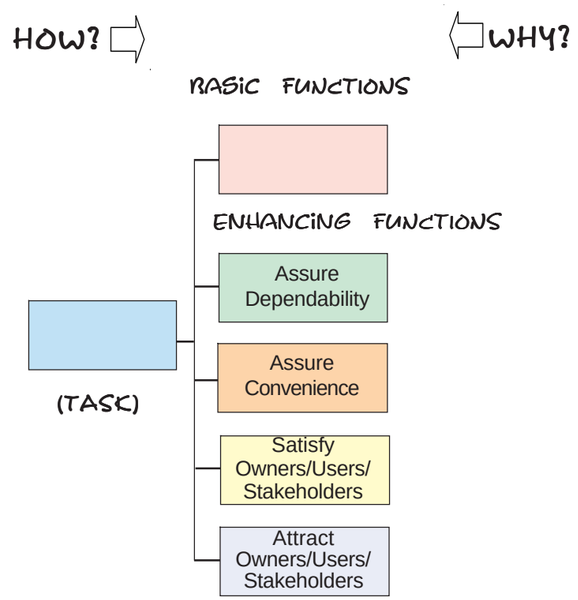


Exhibit 5.1
Structure of Function-Logic Diagram

Functions that assure dependability do the following:

- Make the project stronger
- Make the project more reliable
- Make the project safer - protect the stakeholders
- Lengthens the life of the project
- Reduces maintenance
- Protects the environment

Functions that assure convenience do the following:

- Make the project easier to use
- Contribute to spatial arrangements
- Facilitate maintenance and repair
- Furnish instructions to the stakeholder

Functions that satisfy stakeholders do the following:

- Make the project satisfy individual desires
- Make the stakeholder's life more pleasant, such as minimize noise
- Follow standards and specifications of a stakeholder

Functions that attract stakeholders do the following:

- Emphasize visual aspect of project
- Create a positive image of the project

The Function-Logic Diagram was developed for this project using the How/Why logic. From left to right the Function-Logic Diagram describes how the function will be achieved. As a check on the logic, the Function-Logic Diagram describes why we do something by reading it right to left.

Exhibit 5.2 is the Function-Logic Diagram for the main roadway and Exhibit 5.4 is the Function-Logic Diagram for the service drives. In addition, the cost of the service drives and related bridges were allocated to various functions.

5.2 Function - Cost Analysis

Function cost is a logical, systematic, detailed and arithmetic activity. The VE team considered each element in the cost estimate and determined which functions in the Function-Logic Diagram were impacted. If an element serves only one function, the cost of the element is the same as the cost of the function. If an element serves more than one function, then the cost of the element is apportioned to each function.

Finally, the function costs are added to the Function-Logic Diagram to create a Function-Cost Diagram (Exhibit 5.4).

The Function - Cost Diagram was completed for the service drive as shown in Exhibit 5.4. A high percent of the cost is contained in both Assure Convenience and Satisfy Stakeholders which provides a high opportunity for reducing cost without lowering the value of the project. Ideas were developed to reduce cost, however, were rejected by MDOT based on the eleven commitments shown in Exhibit 7.3.

HOW? ⇨

⇦ WHY?

BASIC FUNCTIONS

IMPROVE LOS

(TASK)

CARRY LOADS

IMPROVE TRAFFIC OPERATIONS

- Improve Bridge Conditions
  - Reconstruct Bridges
  - Rehabilitate Bridges
- Improve Roadway Conditions
  - Overlay Pavement
  - Reconstruct Pavement
- Improve Geometrics
  - Eliminate Left Exits
  - Construct Auxiliary Lanes
  - Improve Sight Distance
- Add Ramp Metering
- Improve Capacity
  - Improve System Interchanges
  - Add Lanes
  - Modify Ramp Spacing

HOW? ⇨ ⇦ WHY?

BASIC FUNCTIONS

(TASK)

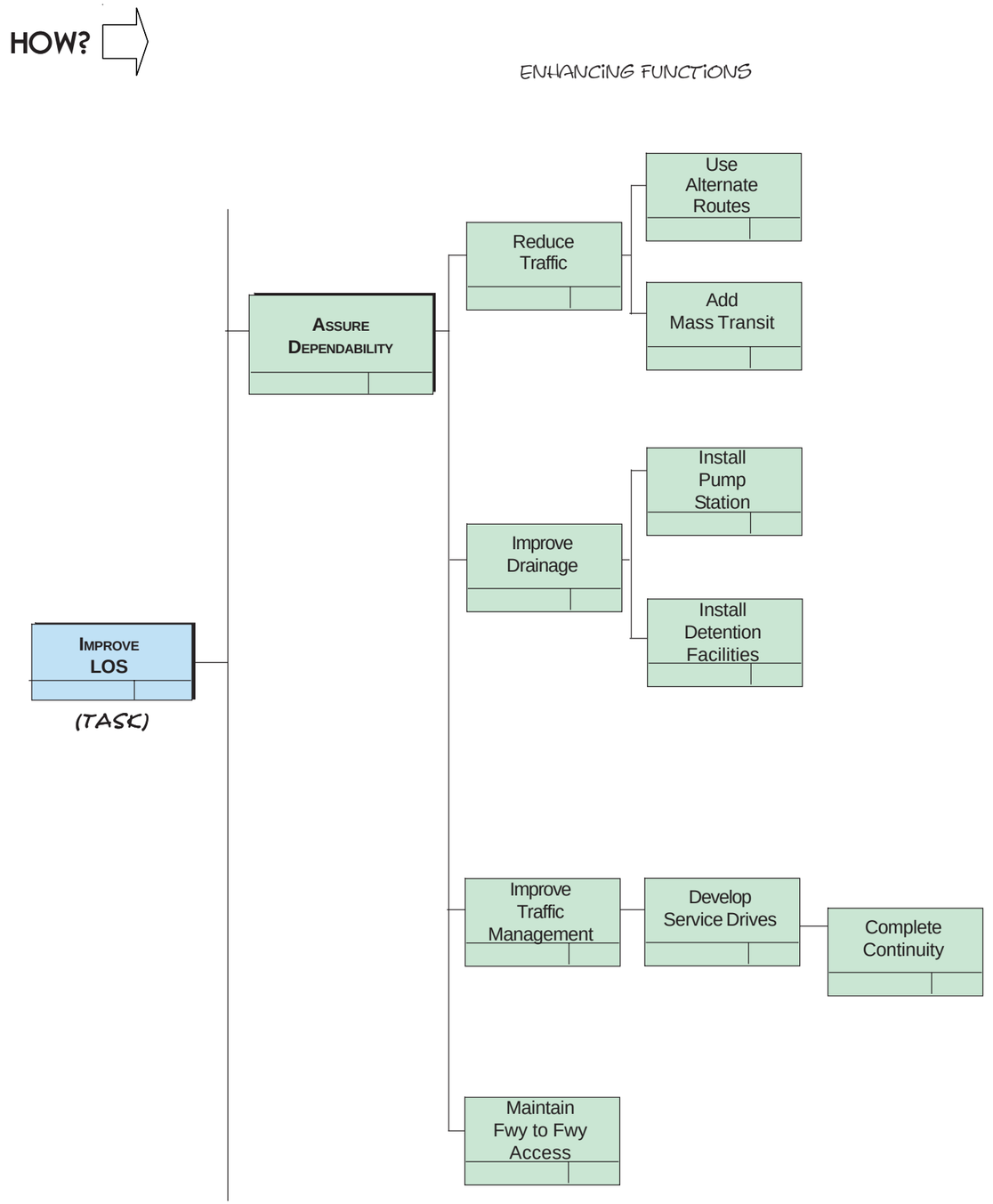
ENHANCING FUNCTIONS

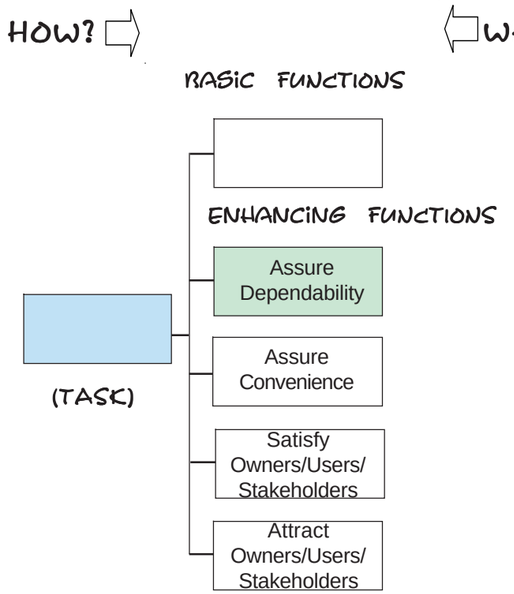
- Assure Dependability
- Assure Convenience
- Satisfy Owners/Users/ Stakeholders
- Attract Owners/Users/ Stakeholders

Function-Logic Diagram Key

Mainline
Function Logic Diagram
(I-94)
Exhibit 5.2

5.0 Function Analysis





Function-Logic Diagram Key

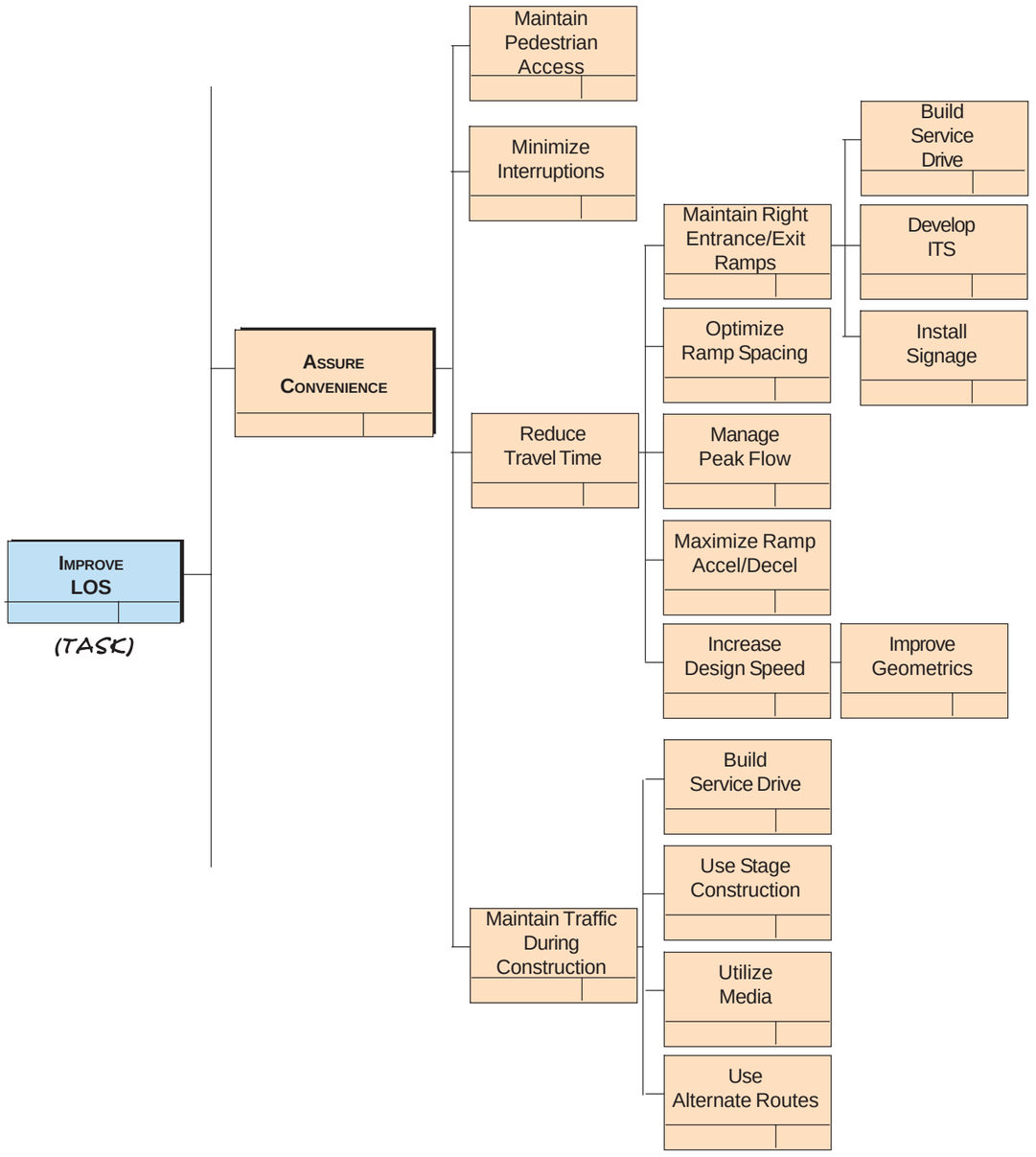
Mainline
Function Logic Diagram
(I-94)
Exhibit 5.2

I-94 EPE VE

5.0 Function Analysis

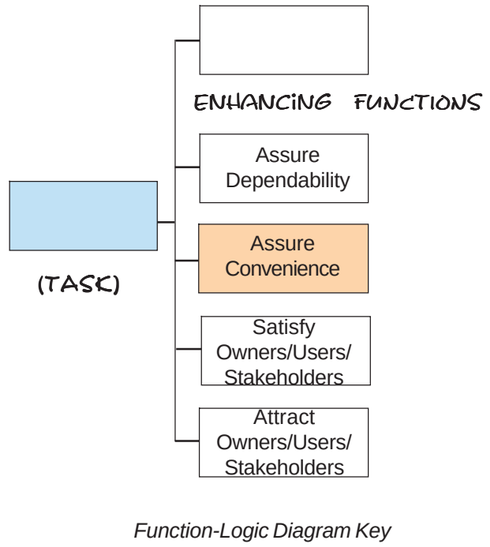
HOW? ⇨ ⇦ WHY?

ENHANCING FUNCTIONS



HOW? ⇨ ⇦ WHY?

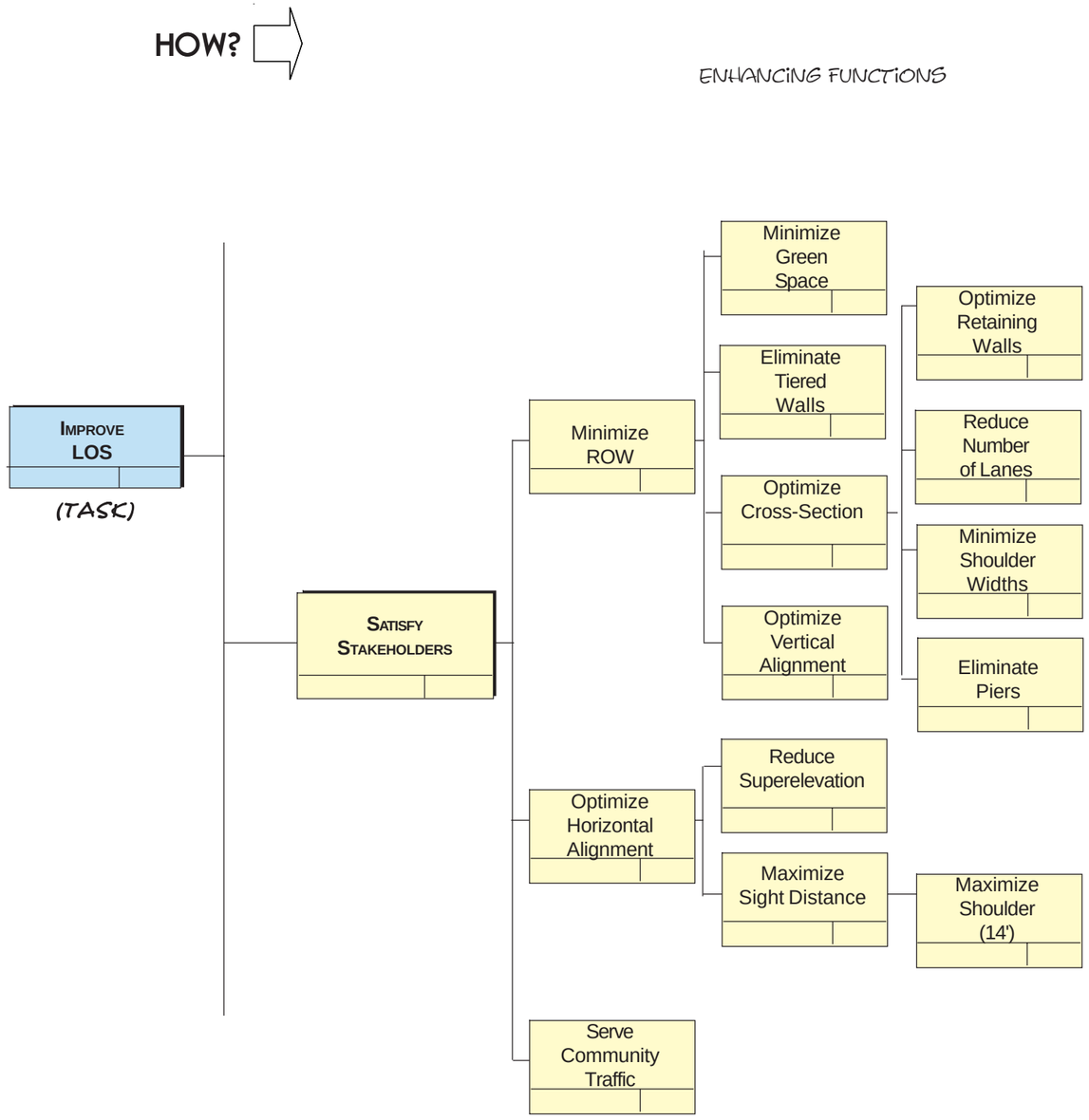
BASIC FUNCTIONS

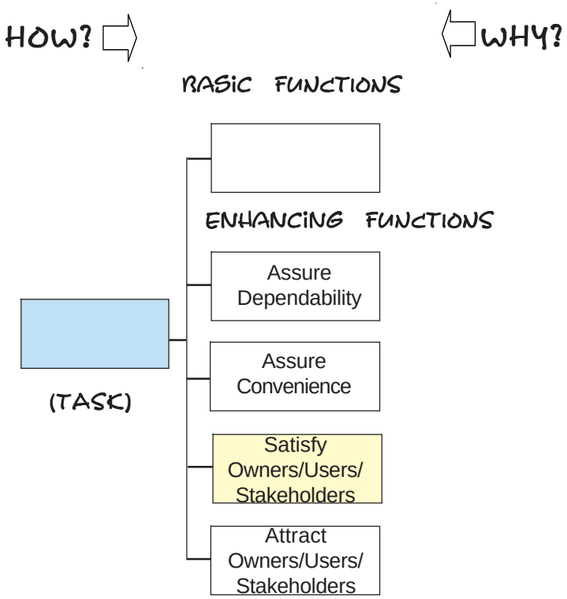


Function-Logic Diagram Key

Mainline
Function Logic Diagram
(I-94)
Exhibit 5.2

5.0 Function Analysis



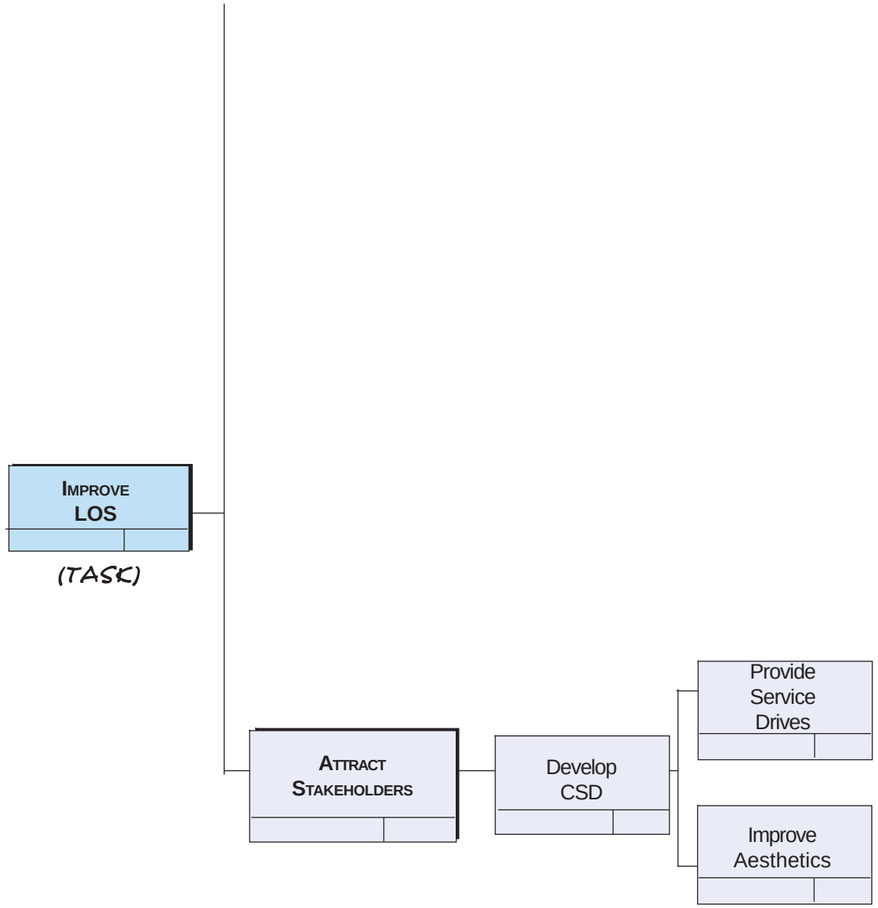


Function-Logic Diagram Key

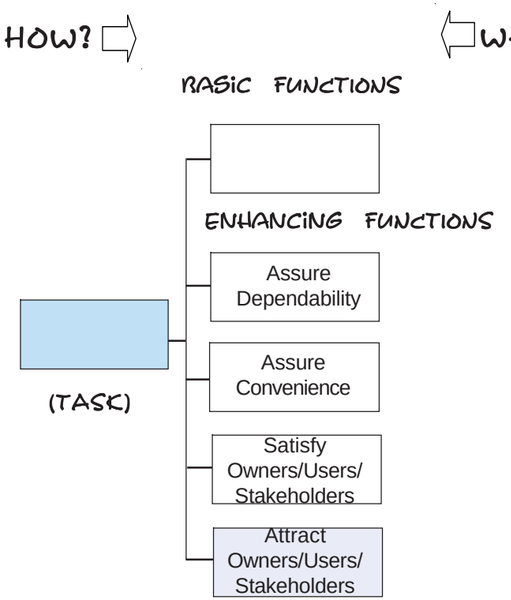
Mainline
Function Logic Diagram
(I-94)
Exhibit 5.2

I-94 EPE VE

HOW? ⇨ ENHANCING FUNCTIONS ⇦ WHY?



HOW? ⇨ BASIC FUNCTIONS ⇦ WHY?



Function-Logic Diagram Key

Mainline
Function Logic Diagram
(I-94)
Exhibit 5.2

5.0 Function Analysis

Service Drive Function Cost Explanation

The function analysis is based on the community's point of view. The cost of the service drive, additional cost of interchanges due to continuity, and the cost of cross bridges and pedestrian bridges is $308,600,000.

The primary reason for the service drive is to serve the community. The secondary reason for the service drive is to satisfy MDOT's needs. Generaly, it is assumed that 75% of the total service drive cost applies toward the community function and 25% towards MDOT's needs. Of the total service drive cost, the cost of the MDOT-related functions are distributed as follows: 5% to facilitate mainline maintenance, 10% to reduce mainline congestion, and 10% to assist mainline incident management. Except at the system interchanges the cost of the right-of-way, cross road bridges, pedestrian bridges, enhancement cost, landscaping, lighting and signals are 100% allocated to the service drive.

Currently the service drive is not continuous. Five percent of the 75% service drive cost is allocated to the missing links [Link Community]. WSU traffic requires a third lane; therefore, five percent of the 75% service drive cost is allocated to the function serve WSU Traffic.

One service lane is assumed to serve the function separate local traffic, and the second lane is assumed to serve the function increase capacity. The eight foot shoulder is to facilitate parking.

Removal of existing structures is not included in the service drive costs. Removal is due to the widening of the mainline, not the building of the service drives.

The total cost of the sidewalk is allocated to safeguard residents.

			Basic Functions				Assure Dependability						Assure Convenience						Satisfy Stakeholder				Attract Stakeholder		
	Total Cost	Base Service Road Cost	Complete Missing Segment	Add Pedestrian Bridges	Maintain Local Cross-Street Access	Separate Local Traffic	Safeguard Residents	Increase Capacity	Manage Traffic	Accommodate Utilities	Facilitate Drainage	Serve WSU Traffic	Facilitate Bus Storage	Maintain Continuity	Minimize Adverse Travel Distance	Increase Mainline Crossing	Facilitate Parking	Facilitate Mainline Maintenance	Reduce Mainline Congestion	Manage Mainline Incident	Encourage Economic Growth	Beautify Neighborhood	Light Street	Maintain Neighborhood Cohesiveness
Element																									
P.O.B. to M-10																									
ASPHALT PAVEMENT (6/12 SECTION)	$ 556,425.87	$ 556,425.87	$ 20,866			$ 137,715		$ 137,715				$ 20,866					$ 100,157								
CONCRETE PAVEMENT (12 over 12 SECTION)																									
3" MILL & OVERLAY	$ -	$ -																							
REMOVAL OF SURFACING	$ -	$ -																							
CURB & GUTTER	$ 248,239.06	$ 248,239.06					$ 93,090				$ 93,090														
SIDEWALK	$ 170,875.00	$ 170,875.00					$ 128,156				$ 93,090														
CONCRETE MEDIAN PAVEMENT																									
VEHICULAR BRIDGES	$ 6,747,100.00	$ 6,657,100.00			$ 3,994,260																$ 2,662,840				
PED BRIDGES		$ 90,000.00		$ 54,000																				$ 36,000	
RETAINING WALLS	$ -	$ -																							
REMOVAL OF STRUCTURES																									
SIGNALS	$ 800,000.00	$ 800,000.00							$ 800,000																
LIGHTING	$ -	$ -																					$ -		
SIGNING	$ 50,000.00	$ 50,000.00							$ 37,500																
STRIPING																									
RR CROSSING	$ -	$ -																							
DRAINAGE	$ 901,884.43	$ 901,884.43									$ 676,413														
M-10 Interchange																									
ASPHALT PAVEMENT (6/12 SECTION)	$ 351,702.00	$ 105,510.60				$ 29,015		$ 29,015									$ 21,102								
CONCRETE PAVEMENT (12 over 12 SECTION)	$ 10,251,150.00	$ 3,075,345.00				$ 845,720		$ 845,720									$ 615,069								
3" MILL & OVERLAY	$ -	$ -																							
REMOVAL OF SURFACING	$ -	$ -																							
CURB & GUTTER	$ 158,749.82	$ 47,624.94					$ 17,859				$ 17,859														
SIDEWALK	$ 164,400.00	$ 49,320.00					$ 36,990																		
CONCRETE MEDIAN PAVEMENT	$ 3,400.00	$ 1,020.00				$ 281		$ 281									$ 204								
VEHICULAR BRIDGES	$ 44,038,200.00	$ 45,620,750.00												$ 13,686,225	$ 20,529,338										
PED BRIDGES		$ 112,500.00		$ 50,625																				$ 33,750	
RETAINING WALLS	$ -	$ -																							
REMOVAL OF STRUCTURES	$ 6,038,750.00	$ -																							
SIGNALS	$ 200,000.00	$ 60,000.00							$ 45,000																
LIGHTING	$ -	$ -																					$ -		
SIGNING	$ 5,000,000.00	$ 1,500,000.00							$ 1,125,000																
STRIPING		$ -																							
RR CROSSING	$ -	$ -																							
DRAINAGE	$ 3,843,951.88	$ 1,153,185.56									$ 864,889														
M-10 to I-75																									
ASPHALT PAVEMENT (6/12 SECTION)	$ 525,774.80	$ 525,774.80	$ 19,717			$ 130,129		$ 130,129				$ 19,717					$ 94,639								
CONCRETE PAVEMENT (12 over 12 SECTION)																									
3" MILL & OVERLAY	$ -	$ -																							
REMOVAL OF SURFACING	$ -	$ -																							
CURB & GUTTER	$ 211,418.46	$ 211,418.46					$ 79,282				$ 79,282														
SIDEWALK	$ 251,735.00	$ 251,735.00					$ 188,801																		
CONCRETE MEDIAN PAVEMENT																									
VEHICULAR BRIDGES	$ 8,870,600.00	$ 8,870,600.00			$ 5,322,360																$ 3,548,240				
PED BRIDGES		$ -		$ -																					
RETAINING WALLS	$ -	$ -																							
REMOVAL OF STRUCTURES																									
SIGNALS	$ 1,400,000.00	$ 1,400,000.00							$ 1,400,000																
LIGHTING	$ -	$ -																							
SIGNING	$ 50,000.00	$ 50,000.00							$ 37,500																
STRIPING																									
RR CROSSING	$ -	$ -																							
DRAINAGE	$ 997,205.55	$ 997,205.55									$ 747,904														

Exhibit 5.3

The curb and gutter cost is allocated as follows: 50% is guide flow (drainage), and 50% is to separate pedestrian/ vehicle traffic.

Thirty percent of the interchange cost is assumed to serve to grade separate the service drive. Of that 30%, 40% is assumed to maintain continuity (enhance transit operation), 60% is assumed to minimize adverse travel distance.

Thirty percent of the non-interchange bridge costs are allocated to maintain local cross street access, and 70 percent is to minimize indirection.

Sixty percent of the bridge cost and 60% of pedestrian cost are allocated to the function Add pedestrian bridges. Forty percent of the pedestrian cost is allocated to the function maintain neighborhood cohesiveness. The remainder of the bridge crossing is allocated to the function encourage economic growth.

Of the $50 million total estimated right-of-way costs, half is attributed to the service drives. Of that $25 million, $10 million is allocated to the function facilitate parking and $15 million is allocated to the function complete missing segment.

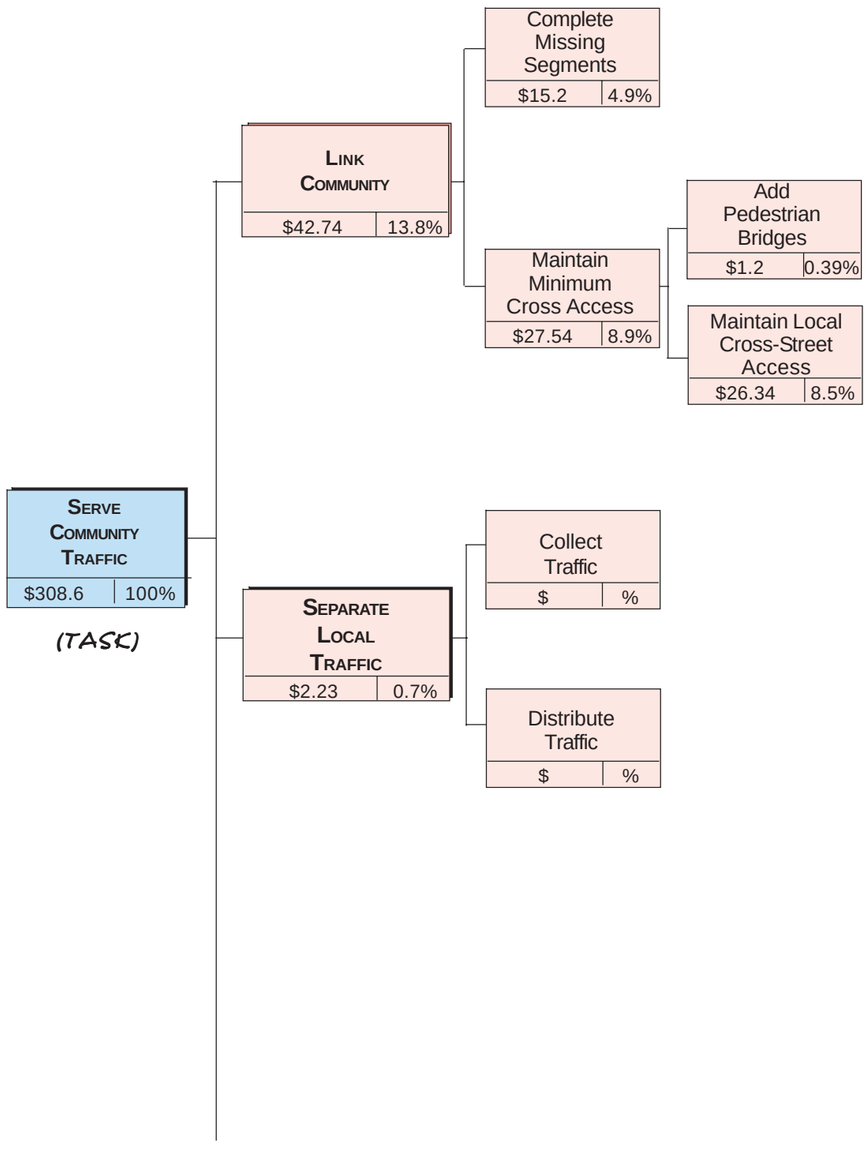
Exhibit 5.3 shows the detailed cost allocation to the functions. Exhibit 5.4 includes these costs in the Function Cost Diagram.

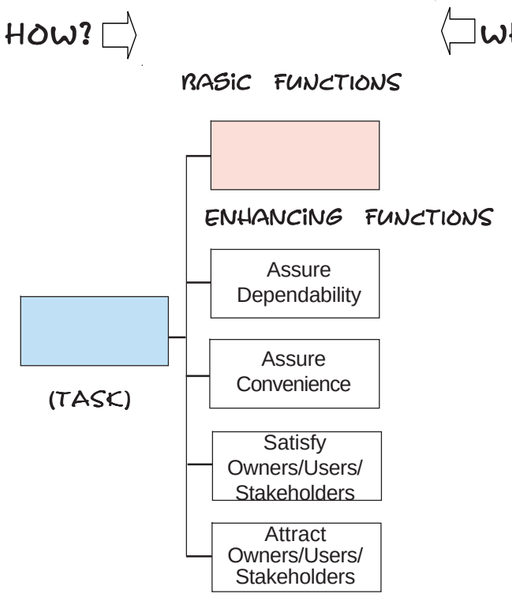
	Total Cost	Base Service Road Cost	Complete Missing Segment	Add Pedestrian Bridges	Maintain Local Cross-Street Access	Separate Local Traffic	Safeguard Residents	Increase Capacity	Manage Traffic	Accommodate Utilities	Facilitate Drainage	Serve WSU Traffic	Facilitate Bus Storage	Maintain Continuity	Minimize Adverse Travel Distance	Increase Mainline Crossing	Facilitate Parking	Facilitate Mainline Maintenance	Reduce Mainline Congestion	Manage Mainline Incident	Encourage Economic Growth	Beautify Neighborhood	Light Street	Maintain Neighborhood Cohesiveness
I-75 Interchange (Service Road 30%)																								
ASPHALT PAVEMENT (6/12 SECTION)	$ 282,119.50	$ 84,635.85				$ 23,275		$ 23,275									$ 16,927							
CONCRETE PAVEMENT (12 over 12 SECTION)	$ 2,851,320.00	$ 855,396.00				$ 235,234		$ 235,234									$ 171,079							
3" MILL & OVERLAY	$ -	$ -																						
REMOVAL OF SURFACING	$ -	$ -																						
CURB & GUTTER	$ 125,103.74	$ 37,531.12					$ 14,074				$ 14,074													
SIDEWALK	$ 157,500.00	$ 47,250.00					$ 35,438																	
CONCRETE MEDIAN PAVEMENT	$ 3,400.00	$ 1,020.00				$ 281		$ 281									$ 204							
VEHICULAR BRIDGES	$ 58,969,200.00	$ 62,190,450.00												$ 18,657,135.00	$ 27,985,703									
PED BRIDGES		$ -		$ -																				$ -
RETAINING WALLS	$ -	$ -																						
REMOVAL OF STRUCTURES	$ 3,221,250.00	$ -																						
SIGNALS	$ 200,000.00	$ 60,000.00							$ 45,000															
LIGHTING	$ -	$ -																					$ -	
SIGNING	$ 5,000,000.00	$ 1,500,000.00							$ 1,125,000															
STRIPING		$ -																						
RR CROSSING	$ -	$ -																						
DRAINAGE	$ -	$ -									$ -													
I-75 to P.O.E.																								
ASPHALT PAVEMENT (6/12 SECTION)	$ 2,182,069.96	$ 2,182,069.96	$ 81,828			$ 540,062		$ 540,062				$ 81,828					$ 392,773							
CONCRETE PAVEMENT (12 over 12 SECTION)																								
3" MILL & OVERLAY	$ 615,981.00	$ 615,981.00	$ 23,099			$ 152,455		$ 152,455				$ 23,099					$ 110,877							
REMOVAL OF SURFACING	$ -	$ -																						
CURB & GUTTER	$ 832,998.63	$ 832,998.63					$ 312,374				$ 312,374													
SIDEWALK	$ 582,275.00	$ 582,275.00					$ 436,706																	
CONCRETE MEDIAN PAVEMENT																								
VEHICULAR BRIDGES	$ 30,192,950.00	$ 28,381,650.00			$ 17,028,990																$ 11,352,660			
PED BRIDGES		$ 1,811,300.00		$ 1,086,780																				$ 724,520
RETAINING WALLS	$ -	$ -																						
REMOVAL OF STRUCTURES																								
SIGNALS	$ 2,600,000.00	$ 2,600,000.00							$ 2,600,000															
LIGHTING	$ -	$ -																					$ -	
SIGNING	$ 200,000.00	$ 200,000.00							$ 150,000															
STRIPING																								
RR CROSSING	$ 400,000.00	$ -																						
DRAINAGE	$ 4,164,799.65	$ 4,164,799.65									$ 3,123,600													
Subtotal	***$ 204,412,529.33***	***$ 179,653,871.48***																						
Removal of Surfacing		$ 551,413.93	$ 20,678			$ 136,475		$ 136,475				$ 20,678					$ 99,255							
Lighting		$ 3,000,000.00																					$ 3,000,000	
Striping		$ 627,350.40							$470,512.80															
Landscaping		$ 2,400,000.00																				$2,400,000		
Subtotal		**$ 186,232,635.81**																						
Utilities (15%)		$ 27,934,895.37								$20,951,172														
Traffic Control (15%)		$ 32,125,129.68							$24,093,847															
Right of Way		$ 25,000,000.00	$15,000,000														$10,000,000							
Subtotal		***$ 271,292,660.86***																						
Total Less Service-Road Specific Items		**$ 190,282,010.86**																9,514,101	19,028,201	19,028,201				
Contingency (25%)		$ 67,823,165.21																						
Mobilization (10%)		$ 33,911,582.61																						
Enhancement (10%)		$ 37,302,740.87																				$37,302,741		
Engineering (25%)		$ 102,582,537.39																						
Total		***$ 431,902,036.93***																						
Total Cost of Functions		**$ 308,595,401.72**	$ 15,166,187	$ 1,191,405	$ 26,345,610	$ 2,230,642	$ 1,342,771	$ 2,230,642	$ 31,929,360	$ 20,951,172	$ 5,929,486	$ 166,187	$ -	$ 32,343,360	$ 48,515,040	$ -	$ 11,622,285	$ 9,514,101	$ 19,028,201	$ 19,028,201	$ 17,563,740	$ 39,702,741	$ 3,000,000	$ 794,270
Percentage of Cost to Functions		100%	4.91%	0.39%	8.54%	0.72%	0.44%	0.72%	10.35%	6.79%	1.92%	0.05%	0.00%	10.48%	15.72%	0.00%	3.77%	3.08%	6.17%	6.17%	5.69%	12.87%	0.97%	0.26%
				Basic Function Total		**$ 44,933,845**			**Assure Dependability Total**		**$ 62,383,431**				**Assure Convenience Total**		**$ 92,646,873**		**Satisfy Stakeholder Total**		**$ 65,134,243**	**Attract Stakeholder Total**		**$ 43,497,011**
				Basic Function Percentage		**14.56%**			**Assure Dependability Percentage**		**20.22%**				**Assure Convenience Percentage**		**30.02%**		**Satisfy Stakeholder Percentage**		**21.11%**	**Attract Stakeholder Percentage**		**14.10%**

Exhibit 5.3a

5.0 Function Analysis

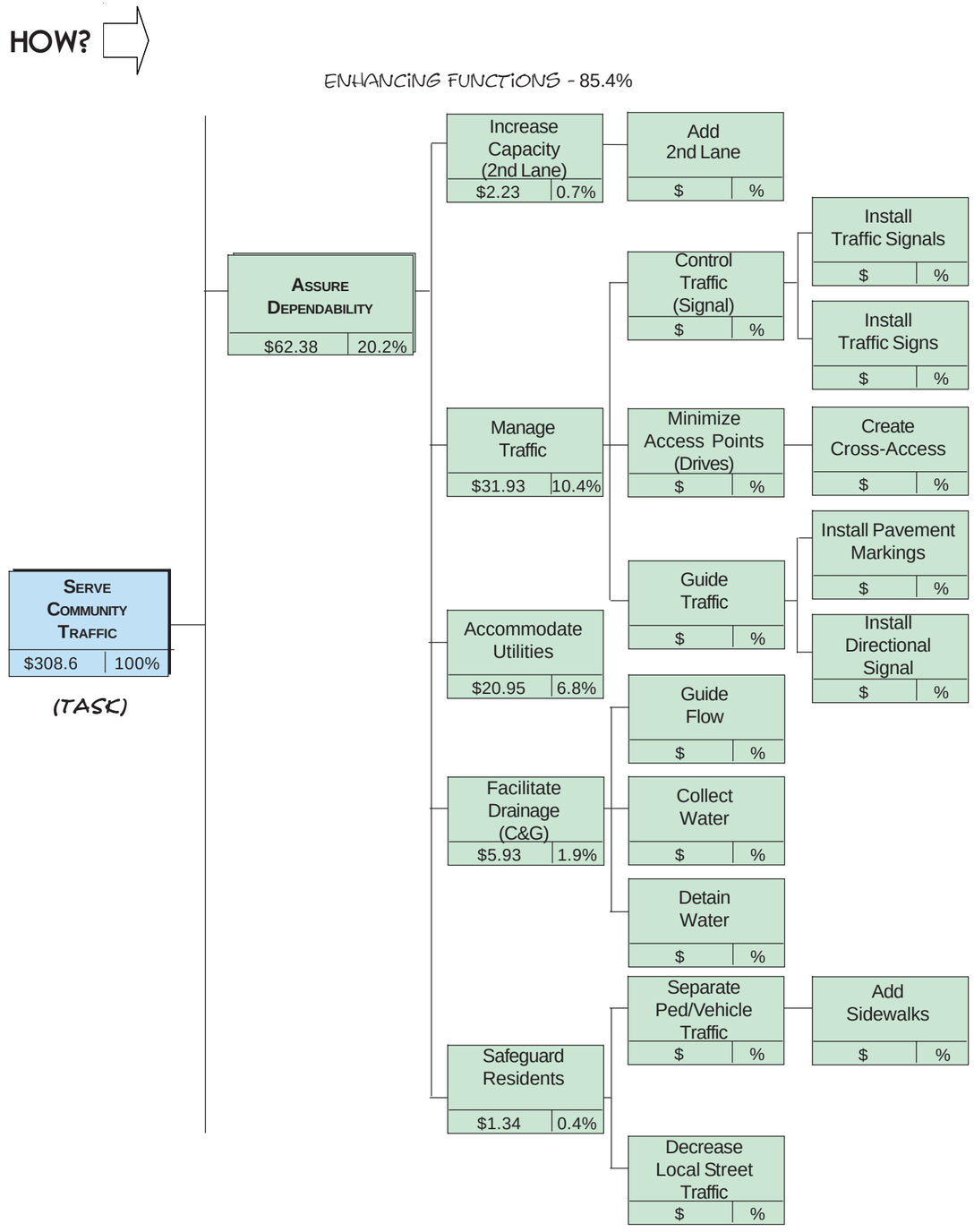
HOW? ⇨ BASIC FUNCTIONS - $44.9 14.6% ⇦ WHY?

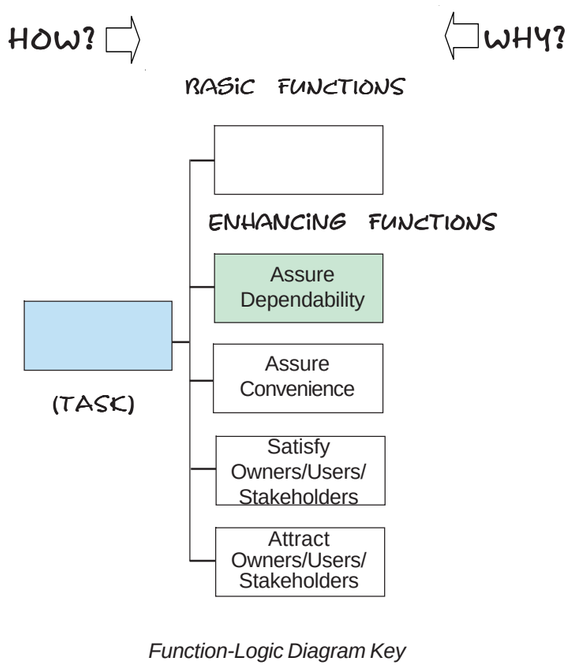




Function-Logic Diagram Key

Service Drives
Function Cost Diagram
Exhibit 5.4

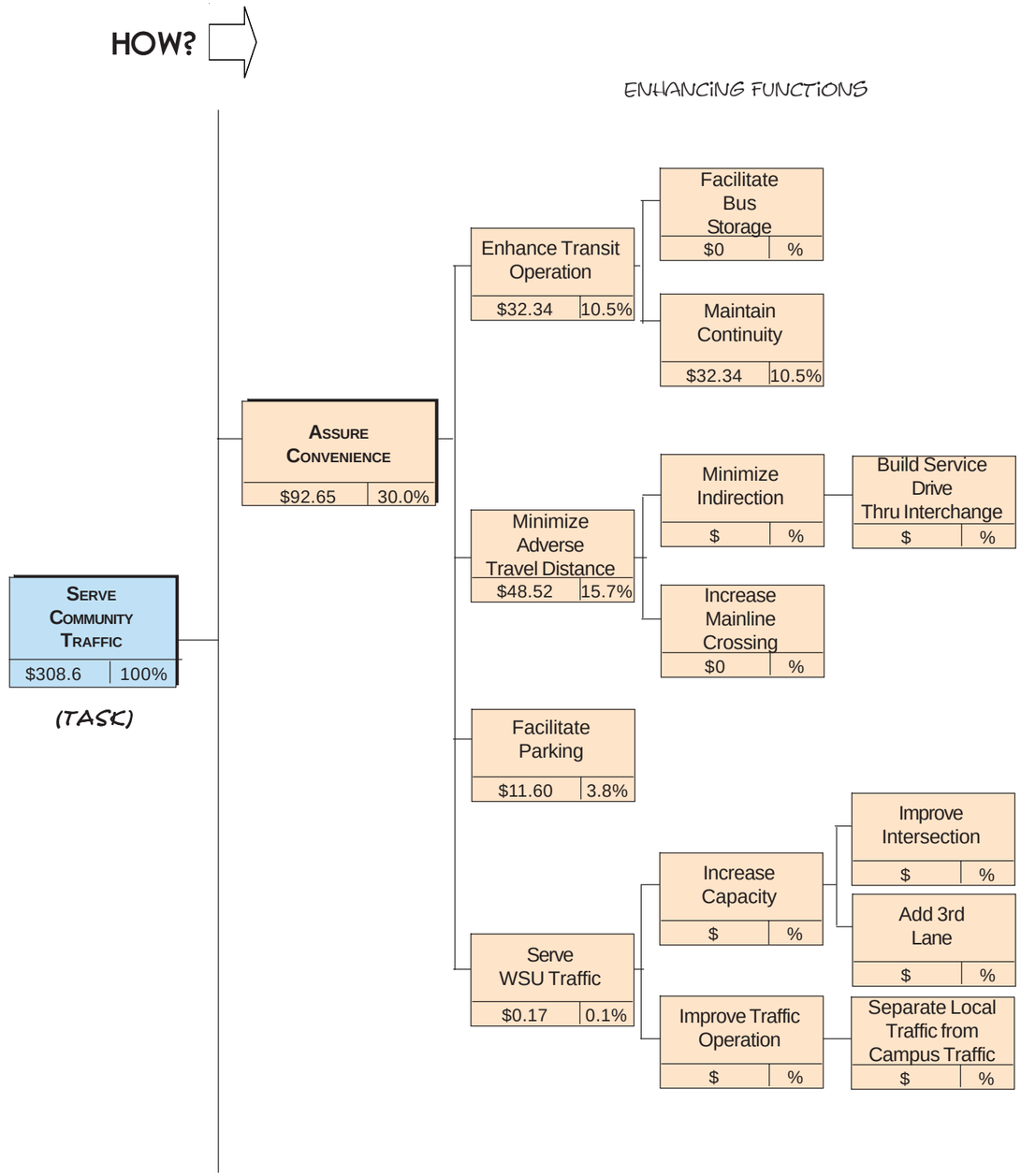


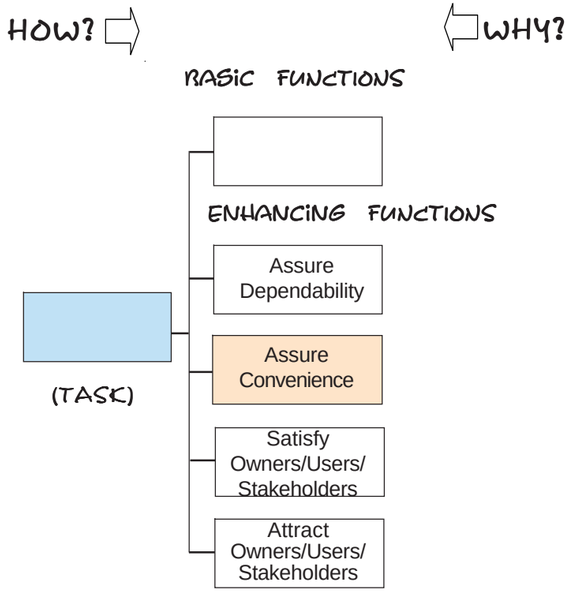


Function-Logic Diagram Key

Service Drives
Function Cost Diagram
Exhibit 5.4

5.0 Function Analysis



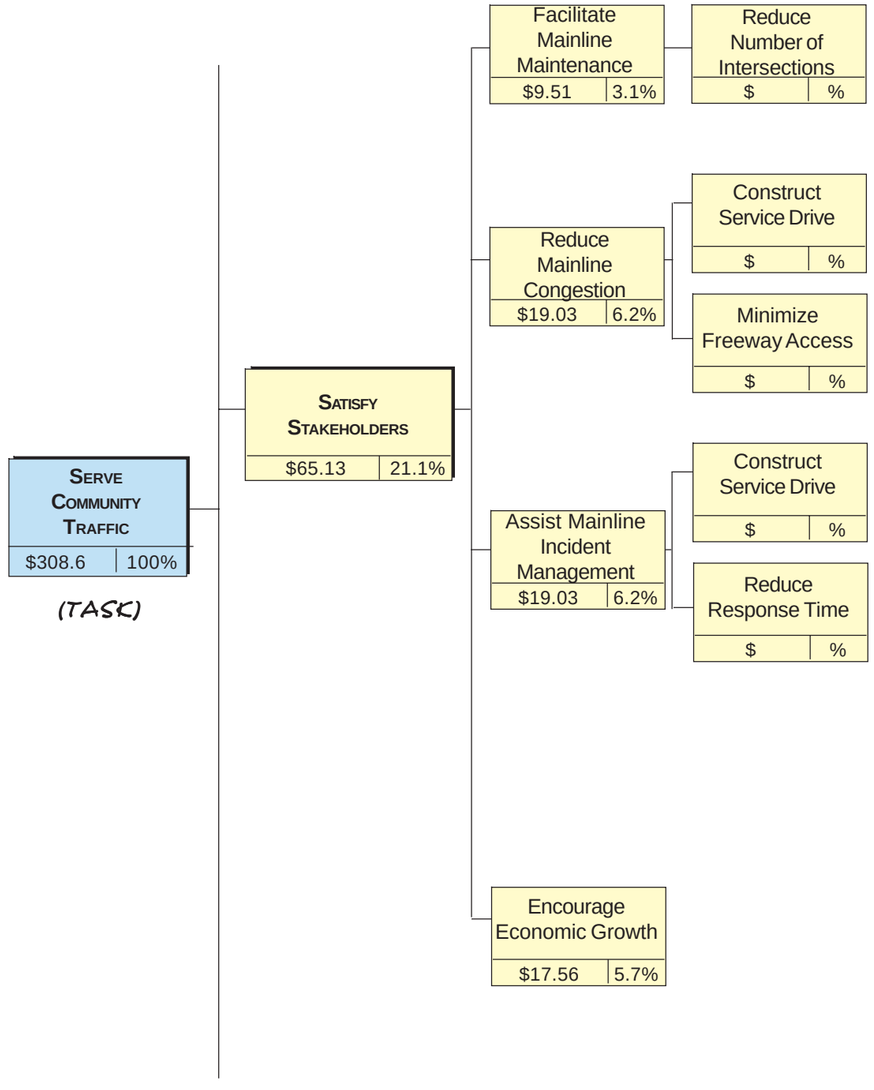


Function-Logic Diagram Key

Service Drives
Function Cost Diagram
Exhibit 5.4

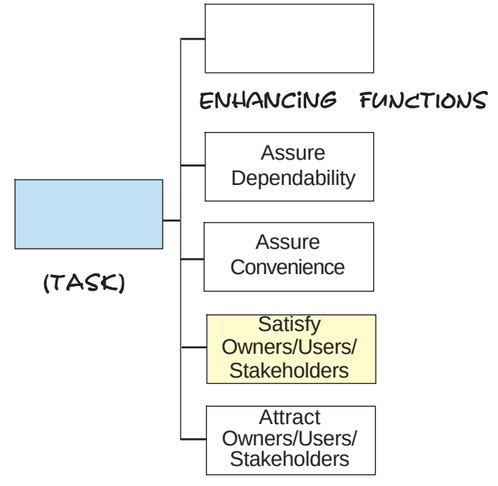
HOW? ⇨ ⇦ WHY?

ENHANCING FUNCTIONS



HOW? ⇨ ⇦ WHY?

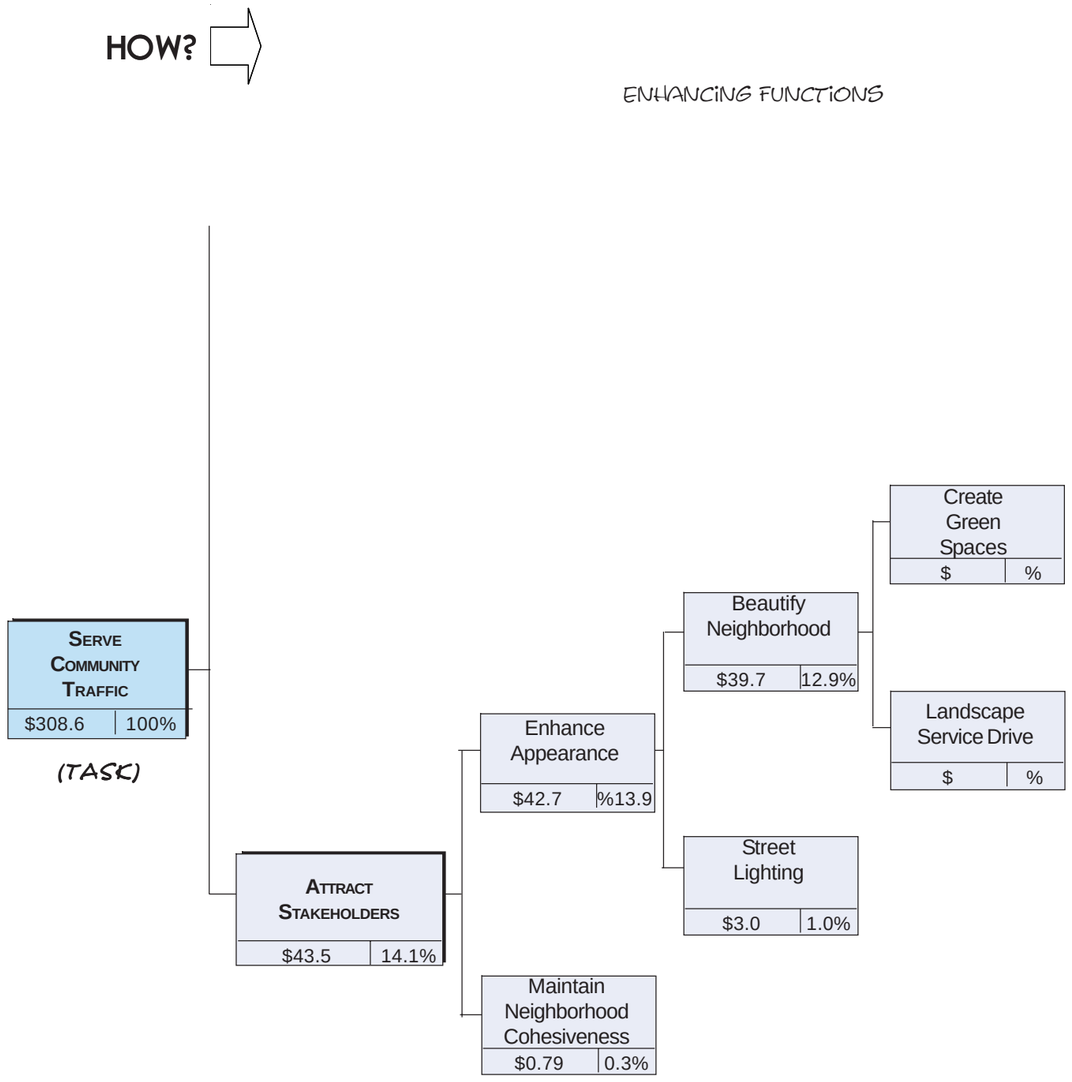
BASIC FUNCTIONS

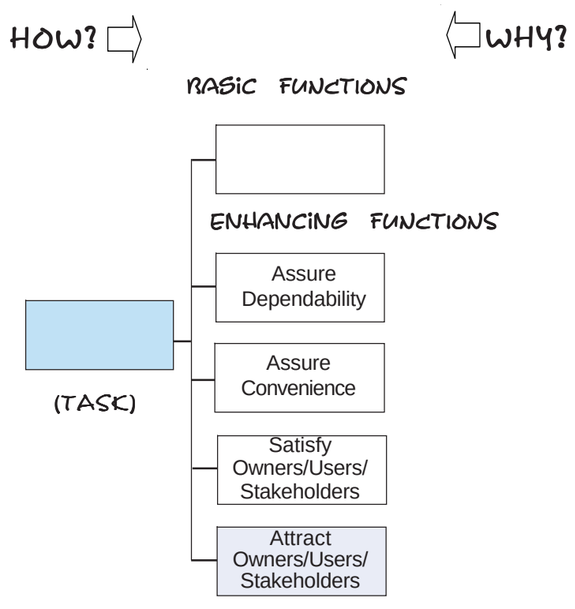


Function-Logic Diagram Key

Service Drives
Function Cost Diagram
Exhibit 5.4

5.0 Function Analysis





Function-Logic Diagram Key

Service Drives
Function Cost Diagram
Exhibit 5.4

6.1 Definition

Following the function analysis, the next step is to answer the question "What else will do the job?" This is the key question in the Speculation Phase.

Speculation may be carried out in at least three ways:

- Random
- By function
- By project element

6.2 Potential Value Engineering Study Areas

The first step in the speculation phase is to list the potential VE Study areas. These areas are as follows:

1. Pedestrian bridges over service drives
2. Service road continuity through the interchanges
3. Typical mainline cross section
4. Typical ramp cross section
5. Local drives cross sections
6. Constructability
7. Level of service on entire system
8. Maintain traffic/alternate routing
9. Construction phasing
10. Build one railroad bridge instead of two at west end of project
11. Storm water systems
12. Utility impacts
13. Tying Harper Avenue into service drives
14. General review of the interchanges
15. Cross street bridges: which ones will be removed, which ones will be rebuilt
16. Structure types (bridges and retaining walls)
17. Substructure placement in interchanges
18. Lodge Freeway interchange: lowering one level
19. Accommodate future expansion
20. Integrate pedestrian crossings with vehicular bridges (eliminate pedestrian bridges)
21. Construct single-lane ramps in system interchanges vs. dual lane ramps
22. Location of ramps & U-turn structures
23. Validate need for all movements
24. Check cost estimates; check details & contingencies
25. Retaining walls on service drives for slopes
26. Aesthetics treatments
27. Landscaping features
28. Location of storm water detention
29. Placement of signs
30. Balance lowering roadway vs. raising structures (or vice versa)
31. Investigate buying a home vs. building a wall, various locations
32. Cantilever service drive (portion) over the mainline to reduce ROW
33. Limits of construction side roads
34. Type of interchanges
35. Reduce 14 ft. median in areas where it is not needed
36. Shifting of south service drive to the north at Mt. Elliott
37. Minimize work on Dequindre Bridge
38. Review location of service drives at east end of project
39. Earthwork balance, particularly if project is constructed in sections
40. What to do with contaminated but nonhazardous materials
41. Tie ramps into Woodward instead of Brush
42. Eliminate service drives at system interchanges
43. Separate service drives and mainline roadway at M-10 Freeway (separate bridges)
44. Revise design to not impact Wayne State University baseball field
45. Use standard bridge type where possible
46. Study need for crash investigation sites
47. Review design criteria
48. Consider design/build contracts for portions or elements of project
49. Desire 21st Century corridor – innovative design such as long-life pavement designs
50. Construct service drives with at-grade crossing of railroad
51. Review methods of accommodating truck wash facilities at DPW building
52. For staged construction, review substructure limits of bridges for potential underground struts
53. Review horizontal alignment of mainline
54. Review alignment of Lodge Freeway at interchange
55. Review location of existing and proposed pump stations

6.3 List of Ideas

During the Speculation Phase, the participants split into two teams to brainstorm ideas.

Muthiah Kasi worked on the allocation of costs for the various functions identified for the project. This resulted in the same number of people assigned to each team, as listed below:

Team 1 - Rich Hill

Steve Fleming	-	Construction
Peter Kinney	-	Roadway
Khaled Soubra	-	Bridge
Kevin Mullins	-	Bridge
John Friel	-	Construction
Marge Lauer	-	Construction/Road
Bill Lambdin	-	Bridge

Team 2 - Darrell Berry

Terry Horst	-	Roadway
Paul Sander	-	Real Estate/Maintenance
Doug Strauss	-	Roadway
Al Kaltenthaler	-	Bridge
Ed Strada	-	Roadway
Cedric Dargin	-	Construction
Laura Aylsworth-Bonzelet	-	Roadway

The following list of ideas is a composite summary of the ideas generated by the two teams.

1. Use alternative types of retaining walls to minimize excavation:
   (a) Secant pile
   (b) Tied-back steel sheeting
   (c) Helical anchor tied back
   (d) Soldier pile and logging
   (e) MSE in fill sections
   (f) Vertical face, cast-in-place concrete
   (g) Crib walls
   (h) Slope paving, say 1:1
2. Use retaining walls instead of grading to save right-of-way.
3. Use slopes instead of retaining walls where right-of-way is available.
4. Eliminate 8 ft. shoulder on two- or three-lane service drives, throughout project.
5. Eliminate 8 ft. shoulder on service drives through interchange areas.
6. Eliminate 8 ft. shoulder on service drives, and build bus turnouts.
7. Eliminate/terminate service drives through two system interchanges.
8. Construct one service drive, two-way traffic, for entire project.
9. Build 24 ft. service drive (16 ft. + 8ft.), single lane, west of M-10 and at east end of project.
10. Eliminate/terminate north-south service drives through M-10 and I-75 Interchanges.
11. Use Harper as a westbound service drive west of I-75.
12. Purchase right of way for entire footprint, but build frontage roads as demand requires.
13. Use Harper as a westbound service drive at east end of project.
14. Connect Harper to service drive west of Frontenac.
15. Eliminate service drive in northeast quadrant of I-75 Interchange, by using East Grand Blvd. and Milwaukee.
16. Use a service road “perimeter system” at the two system interchanges.
17. Near GM, integrate East Grand Blvd. into service drive.
18. Shift eastbound service drive alignment at Mt. Elliott to parallel mainline.
19. In northeast quadrant of I-75 Interchange, relocate service drive to former railroad corridor.
20. For service drives, use existing streets adjacent to system interchanges.
21. In northeast quadrant of M-10 Interchange, put service drive on Antoinette and Holden.
22. Terminate service drives as T-intersection in interchanges.
23. In southeast quadrant of M-10 Interchange, relocate service drive to Palmer.
24. Use at-grade crossings for service drives at railroads (at specific locations).
25. Grade separate service drives at the railroads (at specific locations).
26. Create collector-distributor road system at interchanges, and tie service drives into the collector-distributor roads.
27. Construct single two-way service road only at M-10 and I-75 Interchanges.
28. Eliminate third lane on eastbound service drive at Wayne State University.
29. Minimize green space between service drives and mainline, to minimize real estate, wherever possible.
30. Slope service roads to the outside.
31. For service drives, use two-lane cross section through intersections instead of three lanes at slip ramps.
32. Review proposed traffic signal locations on service roads; some don’t seem warranted.
33. At east end of project, design service drives for future extension.
34. Use 12 ft. median shoulders, for I-94 mainline instead of 14 ft.
35. Use 10 ft. median shoulders for I-94 mainline instead of 14 ft.
36. Use four-foot-wide for barrier, constant width, to accommodate bridge piers, sign bridges, etc.
37. Use minimum width (2'-4") for the barrier, and widen for bridge piers, sign bridges, etc.
38. For I-94, do not pave the earth median, but use double-faced guardrail.

39. Maximize center median width to stay within the existing right-of-way.
40. Use wider median to accommodate sight distance only (on curves).
41. Restrict trucks to outside lanes, to use thinner pavement on inside lanes.
42. Use wider outside lane or lanes for trucks (12'-6" or 13').
43. Pave full depth 14 ft. outside lane, 2 ft. for shoulder, but stripe for 12 ft.
44. Use long-life European style pavement.
45. Use HMA full depth perpetual pavement.
46. Use CRC pavement.
47. Design mainline shoulders as full pavement section.
48. Use inside shoulder for peak hour HOV lane.
49. Use reversible lanes on I-94, in addition to four lanes.
50. Use valley-gutter curb instead of concrete barrier at retaining walls.
51. Set PGL at centerline.
52. Set independent profiles to eliminate differential height median barrier (if PGL is away from roadway centerline).
53. Shift I-94 centerline north between Rosa Park and Woodward.
54. At Mt. Elliott, flatten I-94 curvature, spread out ramp terminals; eliminate design exceptions.
55. Eliminate exit and entrance ramps at Chene.
56. For low volume system interchange exit ramps, construct single lane exit ramps instead of dual lane.
57. At I-75, construct two-lane exit ramps for eastbound and westbound I-94 to I-75 northbound and southbound, instead of successive exits.
58. Tie ramps into Woodward instead of Brush.
59. Use collector-distributor road system between Chene and I-75.
60. For M-10 south of I-94, do not reconstruct south of Warren, except for removal of two ramps immediately south of Warren.
61. Construct single point interchanges at the following locations:
    - Conner
    - Gratiot
    - Van Dyke
    - Mt. Elliott
    - Woodward (possibly)
62. For southbound I-75 movement to service drive, move exit out of interchange.
63. Use split diamond interchange between Van Dyke and Gratiot.
64. For Dequindre Bridge, widen north side only; for exit to Chene, use single lane instead of two.
65. Remove Dequindre Bridge to provide only required roadway clearance, which helps profiles for structures if required in I-75 Interchange.
66. Eliminate Cass Street Bridge.
67. Eliminate Concord Street Bridge (or Frontenac).
68. Eliminate Chene Street Bridge.
69. Eliminate Cadillac Street Bridge.
70. Eliminate Linwood Street Bridge; combine U-turn movement with Grand River Bridge.
71. Eliminate Iroquis and Rohns pedestrian bridges, if Burns remains.
72. Eliminate Helen Street pedestrian bridge.
73. At Gratiot, move U-turn structure west of the bridge.
74. Eliminate all U-turn structures, and eliminate U-turn roadway on structures that have them.
75. Eliminate all pedestrian bridges, but accommodate pedestrians on roadway bridges.
76. Use cable-stayed pedestrian bridges.
77. For two pedestrian bridges at Wayne State University, work with the University to incorporate new structures as part of context sensitive design.
78. Eliminate pedestrian bridge over I-94 at Wayne State, but widen Trumbull Bridge for sidewalks.
79. Shorten pedestrian bridges to touch down between service drives and mainline; add pedestrian crossing signal.
80. Install underpasses for pedestrians.
81. Design pedestrian bridges to span service drives.
82. Eliminate U-turn between East Grand Blvd. and Chene; reconfigure Chene intersection.
83. For CN railroad bridges at west end of project, build one bridge instead of two.
84. Review placement of piers for bridges in I-75 and M-10 Interchanges to determine if span lengths and geometry affect right of way footprint.
85. Instead of pump stations, micro tunnel to river for drainage.
    A. Separate I-94 corridor storm water from city combined system.
    B. Use abandoned railroad corridor for new trunk sewer outfall to river.
86. Use retaining walls in northeast quadrant for I-75 Interchange.
87. Locate opportunities throughout the corridor for areas to use waste material, i.e., earth berms.
88. Close interchange ramps as necessary in opposite movement pairs (detour ramp movements to adjacent interchange).
89. Explore construction staging alternatives. Consider capacity of contractors to be able to build segments.
90. For frontage roads at Dequindre Bridge, build on embankment (1 or 2 ft.) to avoid contaminated material.
91. Provide advanced notice to contracting industry for new technologies materials and construction techniques.